IN THE CLAIMS:

1. A very narrow band two chamber high repetition rate gas discharge laser system comprising:

A) a first laser unit comprising:

1) a first discharge chamber containing;

a) a first laser gas

b) a first pair of elongated spaced apart electrodes defining a first discharge region in which first laser gas discharges occur, each producing a first laser output light pulse,

2) a first fan ~~for~~ producing sufficient gas ~~velocities~~ movement of ~~said~~ the first laser gas in ~~said~~ the first discharge region to clear from ~~said~~ the first discharge region, following each ~~pulse~~ discharge, substantially all discharge produced ions prior to a next ~~pulse~~ discharge when operating at a discharge repetition rate in the range of 4,000 ~~pulses~~ discharges per second or greater,

3) a first heat exchanger system ~~capable of~~ removing ~~at least 16 kw of~~ heat energy from ~~said~~ the first laser gas,

4) a line narrowing unit ~~for~~ narrowing the spectral bandwidth[s] of the first laser light output pulses produced in ~~said~~ the first discharge chamber,

B) a second laser unit comprising:

1) a second discharge chamber containing:

a) a second laser gas,

b) a second pair of elongated spaced apart electrodes defining a second discharge region in which second laser gas discharges occur, each producing a second laser output light pulse;

2) a second fan ~~for~~ producing sufficient gas ~~velocities~~ movement of ~~said~~ the second laser gas in ~~said~~ the second discharge region to clear from ~~said~~ the second discharge region, following each ~~pulse~~ discharge, substantially all discharge produced ions prior to a next ~~pulse~~ discharge when operating at a discharge repetition rate in the range of 4,000 pulses per second or greater,

3) a second heat exchanger system ~~capable of~~ removing ~~at least 16 kw of~~ heat energy from ~~said~~ the second laser gas,

C) a pulse power system ~~configured to~~ provid[e]ing electrical pulses to ~~said~~ the first pair of electrodes and to ~~said~~ the second pair of electrodes sufficient to produce first and second laser output light pulses at rates of about 4,000 laser output light pulses per second with ~~precisely~~ controlled pulse energies comprising: ~~in excess of about 5 mJ, and~~

1) a DC power supply

2) a first commentator module comprising:

a) a first charging capacitor electrically connected to the DC power supply;

b) a first switch periodically switching the energy stored on the first charging capacitor into a first pulse compression circuit electrically connected to the first charging capacitor;

c) a first multi-core fractional turn voltage step-up transformer electrically connected to the first pulse compression circuit;

3) a first pulse compression head module comprising:

a) a second pulse compression circuit electrically connected to the first voltage step-up transformer;

b) a first pulse capacitor electrically connected to the second pulse compression circuit and electrically connected

across the first pair of spaced apart electrodes;

4) a second commutator module comprising:

a) a second charging capacitor electrically connected to the DC power supply;

b) a second switch periodically switching the energy stored on the second charging capacitor into a third pulse compression circuit electrically connected to the second charging capacitor;

c) a second multi-core fractional turn voltage step-up transformer electrically connected to the third pulse compression circuit;

4) a second compression head module comprising:

a) a fourth pulse compression circuit electrically connected to the second voltage step-up transformer;

b) a second peaking capacitor electrically connected to the second pulse compression circuit and electrically connected across the second pair of spaced apart electrodes; and,

D) a laser beam measurement and control system ~~for~~ measuring at least one of the pulse energy, wavelength ~~and~~ or bandwidth of the second laser output light pulses ~~produced by said two chamber laser system~~ and controlling ~~said~~ the second laser output light pulses with ~~in~~ a feedback control[ler] ~~arrangement~~.

2. A laser system as in Claim 1 wherein ~~said~~ the first laser unit is ~~configured as~~ a master oscillator and ~~said~~ the second laser unit is ~~configured as~~ a power amplifier.

3. A laser system as in Claim 2 wherein ~~said~~ the laser gas comprises argon, fluori[~~de~~]ne and a buffer gas ~~neon~~.

4. A laser system as in Claim 2 wherein ~~said~~ the laser gas comprises krypton, fluorine and a buffer gas ~~neon~~.

5. A laser system as in Claim 2 wherein ~~said~~ the laser gas comprises fluorine and [~~a~~] the buffer gas is chosen from a group consisting of neon, helium or a mixture of neon and helium.

6. A laser system as in Claim 2 wherein [~~said~~] the power amplifier ~~is configured for~~ achieves amplification at least in part due to two beam passes through the second discharge region.

7. A laser system as in Claim 2 wherein ~~said~~ the power amplifier achieves amplification ~~is configured for~~ due to at least four beam passes through the second discharge region.

8. A laser as in Claim 2 wherein ~~said~~ the master oscillator comprises ~~is configured to provide~~ a resonant path making two passes through ~~said~~ the first discharge region.

9. A laser as in Claim 2 wherein ~~said~~ the master oscillator ~~is configured to provide~~ comprises a resonant path making two passes through ~~said~~ the first discharge region and wherein ~~said~~ the power amplifier ~~is configured for~~ comprise a path for at least four beam passes through the second discharge region

~~10. A laser system as in Claim 1 and further comprising an optical table for supporting resonant cavity optics of said first laser unit independent of said first discharge chamber.~~

~~11. A laser system as in Claim 7 wherein said optical table is generally U-shaped and defines a U-cavity and wherein said first discharge chamber is mounted within the U-~~

~~cavity.~~

~~12. A laser as in Claim 1 and further comprising a vertically mounted optical table with said first and second discharge chambers mounted on said vertical optical table.~~

~~13. A laser system as in Claim 1 wherein each of said first and second laser chambers define a gas flow path with a gradually increasing cross section downstream of said electrodes to permit recovery of a large percentage of static pressure drop occurring in the discharge regions.~~

~~14. A laser as in Claim 2 and wherein said chamber also comprises a vane structure upstream of said discharge region for normalizing gas velocity upstream of said discharge region.~~

~~15. A laser as in Claim 1 wherein said first fan and said second fan each are tangential fans and each comprises a shaft driven by two brushless DC motors.~~

~~16. A laser as in Claim 15 wherein said motors are water cooled motors.~~

~~17. A laser as in Claim 15 wherein each of said motors comprise a stator and each of said motors comprise a magnetic rotor contained in a pressure cup separating a said stator from said laser gas.~~

~~18. A laser as in Claim 1 wherein said first and second fans are each tangential fans each comprising a blade structure machined from said aluminum stock.~~

~~19. A laser as in Claim 15 wherein said blade structure has an outside diameter of about five inches.~~

~~20. A laser as in Claim 19 wherein said blade structures comprise blade elements~~

~~having sharp leading edges.~~

~~21. A laser as in Claim 15 wherein said motors are sensorless motors and further comprising a master motor controller for controlling one of said motors and a slave motor controller for controlling the other motor~~.

~~22. A laser as in Claim 15 wherein each of said tangential fans comprise blades which are angled with respect to said shaft.~~

~~23. A laser as in Claim 1 wherein each finned heat exchanger system is water cooled.~~

~~24. A laser as in Claim 23 wherein each heat exchanger system comprises at least four separate water cooled heat exchangers.~~

~~25. A laser as in Claim 23 wherein each heat exchanger system comprises at least one heat exchanger having a tubular water flow passage wherein at least one turbulator is located in said path.~~

~~26. A laser as in Claim 25 wherein each of said four heat exchangers comprise a tubular water flow passage containing a turbulator.~~

27. A laser as in Claim 1 wherein ~~said~~ <u>the</u> pulse power power system comprise[s] water cooled electrical components.

28. A laser as in Claim 27 wherein at least one of ~~said~~ <u>the</u> water cooled components is a component operated at high voltages in excess of 12,000 volts.

29. A laser as in Claim 28 wherein ~~said~~ <u>the</u> high voltage is isolated from ground using a[n] <u>water cooled</u> inductor ~~through which cooling water flows~~.

30. A laser as in Claim 1 wherein ~~said~~ the ~~pulse power system~~ the DC power supply comprises a resonant charging system to charge [a] the charging capacitor first and the second to a precisely controlled voltage.

31. A laser as in Claim 30 wherein ~~said~~ the resonan[ce][t] charging system comprises a De-Qing circuit.

32 . A laser as in Claim 30 wherein ~~said~~ the resonan[ce][t] charging system comprises a bleed circuit.

33. A laser as in Claim 30 wherein ~~said~~ the resonant charging system comprises a De-Qing circuit and a bleed circuit.

34. A laser as in Claim 1 wherein ~~said~~ the pulse power system comprises a charging system comprised of at least three power supplies arranged in parallel.

~~35. A laser as in Claim 1 wherein said laser beam measurement and control system comprises an etalon unit, a photo diode array, a programmable logic device, and optics to focus laser light from said etalon unit on to said photo diode array wherein said programmable logic device is programmed to analyze data from said photodiode array to determine locations on said photo diode array of etalon fringes.~~

~~36. A laser as in Claim 35 wherein said measurement an control system also comprises a microprocessor programmed to calculate wavelength and bandwidth from fringe data located by said programmable logic device.~~

~~37. A laser as in Claim 35 wherein said programmable logic device is programmed with an algorithm for calculating wavelength and bandwidth based on measurement of said fringes.~~

~~38. A laser as in Claim 37 wherein said programmable logic device is configured to make calculations of wavelength and bandwidth faster than 1/4,000 of a second.~~

~~39. A laser as in Claim 35 wherein said etalon unit comprises a defractive diffusing element.~~

~~40. A laser as in Claim 1 and further comprising a line narrowing unit comprising a tuning mirror driven at least in part by a PZT drive.~~

~~41. A laser as in Claim 40 wherein said tuning mirror is also driven in part by a stepper motor.~~

~~42. A laser as in Claim 40 and further comprising a pretuning means.~~

~~43. A laser as in Claim 40 and further comprising an active tuning means comprising a learning algorithm.~~

~~44. A laser as in Claim 40 and further comprising an adaptive feed forward algorithm.~~

~~45. A laser as in Claim 40 wherein said line narrowing unit comprises a grating defining a grating face and a purge means for forcing purge gas adjacent to said grating face.~~

~~46. A laser as in Claim 1 wherein said line narrowing unit also comprises a four-prism beam expander configured to expand a beam in a single direction by a factor of about 45.~~

~~47. A laser as in Claim 40 wherein said purge gas is helium.~~

~~48. A laser as in Claim 1 and further comprising a nitrogen purge system comprising a nitrogen purge system comprising a nitrogen filter.~~

~~49. A laser as in Claim 1 and further comprising a nitrogen purge system comprising a purge module comprising flow monitors said laser also comprising purge exhaust tubes for transporting exhaust purge gas from said laser.~~

~~50. A laser as in Claim 1 and further comprising a shutter unit comprising an electrically operated shutter and a power meter which can be positioned in a laser output beam path with a command signal.~~

~~51. A laser as in Claim 1 and further comprising a beam enclosure system providing a first beam seal between a first window of said first chamber and line narrowing unit and a second beam seal between a second window of said first chamber and an output coupler unit, each of said beam seals comprising a metal bellows.~~

~~52. A laser as in Claim 51 wherein each of said first and second beam seals are configured to permit easy replacement of said laser chamber.~~

~~53. A laser as in Claim 51 wherein each of said beam seals contain no elastomer, provide vibration isolation from said chamber, provide beam train isolation from atmospheric gases and permit unrestricted replacement of said laser chamber without disturbance of said LNP or said output coupler unit.~~

~~54. A laser as in Claim 51 wherein said beam enclosure system comprise vacuum compatible seals.~~

~~55. A laser as in Claim 54 wherein a plurality of said seals are easy sealing bellows seals configured for easy removal by hand.~~

~~56. A laser as in Claim 1 wherein said measurement and control system comprises a primary beam splitter for splitting off a small percentage of output pulses from said laser, a second beam splitter for directing a portion of said small percentage to said pulse energy detector and a means isolating a volume bounded said primary beam splitter, said secondary beam splitter and a window of said pulse energy detector from other portions of said measurement and control system to define an isolated region.~~

~~57. A laser as in Claim 56 and further comprising a purge means for purging said isolated region with a purge gas.~~

~~58. A laser as in Claim 57 wherein said laser further comprises an output coupler unit and an output window unit said purge means being configured so that exhaust from said isolated region also purges said output coupler unit and said output window unit.~~

~~59. A laser system as in Claim 1 wherein said system is configured to operate either of a KrF laser system, an ArF laser system or an F_2 laser system with minor modifications.~~

60. A laser system as in Claim 1 wherein substantially all components are contained in a laser enclosure but ~~said~~ the system comprises an AC/DC module physically separate from the enclosure.

61. A laser system as in Claim 1 wherein ~~said~~ the pulse power system comprises a master oscillator charging capacitor bank and a power amplifier charging capacitor bank and a resonant charger configured to charge both charging capacitor banks in parallel.

62. A laser as in Claim 19 ~~61~~ wherein ~~said~~ the pulse power system comprises a power supply configured to furnish at least 2000V supply to ~~said~~ the resonant charg[es]ing system.

~~63. A laser as in Claim 1 and further comprising a gas control system for controlling F_2 concentrations in said first laser gas to control master oscillator beam parameters.~~

~~64. A laser as in Claim 1 and further comprising a gas control system for controlling laser gas pressure in said first laser gas to control master oscillator beam parameters.~~

65. A laser as in Claim 2 and further comprising a discharge timing controller for triggering discharges in ~~said~~ the power amplifier to occur between 20 and 60 ns after discharges in ~~said~~ the master oscillator.

66. A laser as in Claim 2 and further comprising a discharge timing controller programmed to cause in some circumstances discharges so timed to avoid any significant output pulse energy.

67. A laser as in Claim 66 wherein ~~said~~ the discharge timing controller in ~~said~~ some circumstances is programmed to cause discharge in ~~said~~ the power amplifier at least 20 ns prior to discharge in ~~said~~ the master oscillator.

~~68. A laser as in Claim 1 and further comprising a pulse multiplier unit for increasing duration of output pulses from said laser.~~

~~69. A laser as in Claim 68 wherein pulse multiplier unit is arranged to receive said output pulse laser beam and to multiply the number of pulses per second by at least a factor of two so as to produce a single multiplier output pulse beam comprised of a larger number of pulses with substantially reduced intensity values as compared with the laser output pulses, and pulse multiplier unit comprising:~~

~~(1) a first beam splitter arranged to separate a portion of said~~

~~output beam, the separated portion defining a delayed portion, and the output beam defining a beam size and angular spread at said first beam splitter;~~

~~(2) a first delay path originating and terminating at said first beam splitter said first delay path comprising at least two focusing mirrors, said mirrors being arranged to focus said delayed portion at a focal point within said first delay path and to return said delayed portion to said first beam splitter with a beam size and angular spread equal to or approximately equal to the beam size and angular spread of the output beam at said first beam splitter.~~

~~70. A laser system as in Claim 69 wherein said at least two focusing mirrors are spherical mirrors.~~

~~71. A laser system as in Claim 69 and further comprising a second delay path comprising at least two spherical mirrors.~~

~~72. A laser system as in Claim 69 wherein said first delay path comprises four focusing mirrors.~~

~~73. A laser system as in Claim 72 and further comprising said second delay path created by a second beam splitter located in said first delay path~~.

~~74. A laser as in Claim 69 wherein said first delay path comprises a second beam splitter and further comprising a second delay path comprising at least two focusing mirrors, said mirrors being arranged to focus said delayed portion at a focal point within said first delay path and to return said delayed portion to said first beam splitter with a beam size and angular spread equal to or approximately equal to the beam size and angular spread of the output beam at said first beam splitter.~~

~~75.~~ ~~A laser as in Claim 69 wherein said first beam splitter is configured to direct a laser beam in at least two directions utilizing optical property of frustrated internal reflection.~~

76. ~~A laser as in Claim 69 wherein said first beam splitter is comprised of two transparent optical elements each element having a flat surface, said optical elements being positioned with said surfaces parallel to each other and separated by less than 200 nm.~~

77. ~~A laser as in Claim 69 wherein said first beam splitter is an uncoated optical element oriented at an angle with said output laser beam so as to achieve a desired reflection-transmission ratio.~~